

The SecoGear logo features a green stylized roof icon above the word "Seco" in green and "Gear" in blue.

24kV-27kV

Air Insulation Switchgear

User Manual



GE imagination at work

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Safety first!

Important Recommendations:

- Switchgear should be installed in a clean, dry, ventilated room.
- Switchgear and/or switchboards should be installed in closed rooms suitable for electrical equipment.
- Installation, operation and maintenance should be carried out by licensed electricians.
- Fully comply with the applicable standards (e.g. IEC), the utility connection requirements and the applicable safety regulations.
- Observe the relevant instructions in the instruction manual for all actions in relation to switchgear and switchboards.
- Pay attention to the hazard notes in the instruction manual marked with this ⚠ warning symbol.
- Make sure that the specified data are not exceeded under switchgear or switchboard operating conditions.
- Keep the instruction manual accessible to all personnel involved in installation, operation and maintenance.
- The users must act responsibly in all matters affecting safety at work and correct handling of the switchgear.



Warning

- Always follow the instruction manual and respect the rules for good engineering practice!
- Hazardous voltage can cause electrical shocks and burns.
- Disconnect power, then earth and short-circuit before proceeding with any work on the equipment.

If you have any further questions about this instruction manual, our field team will be pleased to provide the required information.

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General

Summary

This publication contains the information required for installation, commissioning, operation and maintenance of SecoGear. SecoGear is three-phase, metal enclosed, air-insulated factory assembled switchgear. SecoGear is type-tested and suitable for indoor applications up to 27 kV. The panel is designed with withdrawable modules and is fitted with a single busbar system. The withdrawable parts are equipped with circuit breakers, voltage transformers, fuses or current transformers.

Details of the technical design and configuration of individual

switchgear, such as the technical data, detailed part lists for the individual panels and comprehensive circuit documentation etc., can be found in the relevant order documents.

For correct usage of the switchgear, please read this manual carefully. It is always advisable to use the manual for all operations regarding installation, commissioning, operation and maintenance of SecoGear air-insulated switchgear.

These instructions are also used as references for personnel to carry on regularly maintenance of the switchgear.

Standard and Specification

- SecoGear complies with the standards and specifications for factory-assembled, metal enclosed and type tested high voltage switchgears to IEC publications as given below.

IEC62271-100: 2008	.....	High-voltage alternating current circuit breakers.
IEC62271-200: 2003	.....	AC Metal enclosed switchgear and control gear for rated voltages above 1kV and up to 52kV.
IEC62271-102: 2001	.....	High-voltage alternating current Disconnectors and Earthing Switches.
IEC62271-1: 2007	.....	The common specification for high voltage switchgear and control gear simple Standards
IEC60529:1989	.....	Degrees of protection as provided by enclosures (IP Code)

The switchgear has the following degrees of protection:

IP 4X applies for the enclosure and IP 2X applies for the partitions.

All other corresponding IEC publications, national or local safety regulations must be followed during the installation and operation of the switchgear. In addition, any project specific advice from GE must be considered.

Operating Conditions

Normal operating conditions

The switchgear is fundamentally designed for the normal service conditions for indoor switchgear to IEC Publication 62271-1:2007. The following limitations apply. (If there are others we should detail the limitations)

- Ambient temperature
 - Maximum + 40°C
 - 24h-Medium + 35°C
 - Minimum - 15°C
- Humidity
 - Highest average value measured over 24 hours
 - o Relative humidity 95 %
 - Highest average value measured over 1 month
 - o Relative humidity 90 %
- The maximum site altitude is 1000 m above sea level
- The intensity of earthquake should not exceed level 8

Special operating conditions

SecoGear is suitable for operation in the climate of indoor type according to IEC 62271-200 standard. Special operating conditions must be discussed with the manufacturer in advance. For example: At site altitudes above 1000 m, the effects of the reduction in density of air on the dielectric properties must be taken into account.

Increased ambient temperatures must be compensated for in the design of the busbar and the branch conductors as well as the withdrawable parts; otherwise the current carrying capacity will be reduced. Fitting additional ventilation facilities can assist heat dissipation in the switchgear panel.

Note on any special climatic operating conditions

When the switchgear is operated in areas with high humidity and/or major rapid temperature fluctuations, there is a risk of condensation. Preventive actions (e.g. applying an electric heater) must be consulted with the manufacturer to avoid condensation and any resulting corrosion or other adverse effects. The control of the heaters depends on the particular project are available.

Safety and Environment Protection Requirement

Safety Procedure



- Wear safety uniform according to electric safety regulations before entering the site
- Comply with industry work procedure. Power supply shall be operated by authorized staff.

Environment protection requirements

The manufacturer has a product recycle policy in accordance with related law and ISO14001. Local laws shall be observed when the switchgear is due for recycle.

Handling and Storage

Condition on delivery

At the time of dispatch, the factory assembled SecoGear will have withdrawable parts either securely locked in the service position or packed separately, depending on the rating of the equipment, transport mode and destination.

The SecoGear panels are verified in the factory for completeness as per order requirement, and also passed routine testing as per IEC 62271-200.

The busbars are not assembled, they are packed separately with fasteners and accessories.

Packing

Based on the kind of transportation and country of destination, the packing may vary. To protect against moisture a drying agent bag is provided. IEC62271-1:2007 guidelines are followed.

- Panels with basic or no packing
- Panels with seaworthy or similar packing (including packing for containerized shipments)
 - o Sealed in polyethylene sheeting
 - o Transport drying agent bags included
 - o Moisture indicator included
- Observe the directions for use of the drying agent bags. Note the following
 - o Drying agent color observed blue indicates the packaged equipment is dry condition
 - o Drying agent color observed pink indicates the packaging contains moisture (relative humidity above 40%). Please contact the manufacturer in this case before installation

Transport

The transport units normally comprise of individual panels and, in exceptional cases, small groups of panels. The panels are equipped with four (4) lifting eyebolts.

Only carry out loading operations when all precautionary measures to protect personnel and materials have been taken, with the following equipment:

- Crane of suitable capacity; the minimum capacity shall be 2 tonnes
- Fork-lift truck and/or manual trolley
- Lifting ropes/slings of appropriate load capacity with shackles
- Maintain an angle of at least 60° from the front for the ropes leading to the crane hook (Figure 1/1)

HANG THE UNITS USING ALL 4 EYEBOLTS!

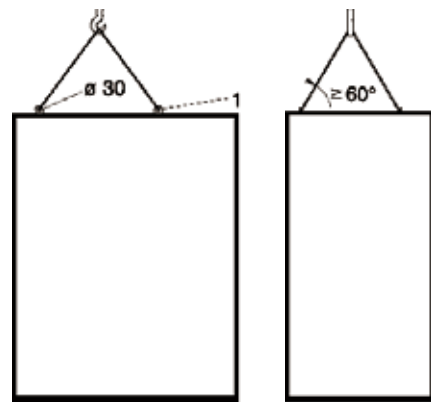


Figure 1/1: Handling by crane
(1) Lifting eyebolts (qty.4)

Upon Receipt

The responsibilities of the consignee when the switchgear arrives at the site include, but are not limited to, the following:
Check the consignment is complete and without damage (e.g. look for any adverse effect caused by moisture). In case of doubt, the packing must be opened and then properly resealed with new drying agent bags (when intermediate storage is necessary).

If any quantities are short, or defects or transport damage is noted, these must be:

- Documented on the respective shipping document
- Notified to the relevant carrier or forwarding agent immediately in accordance with the relative liability regulations

Note: Always take photographs to document any major damage.

Intermediate storage

Intermediate storage should follow the following practices to avoid any negative consequences:

Panels with basic packing or without packing

- A dry well-ventilated storeroom with a climate in accordance with IEC62271-1:2007
- Store the panels upright
- Do not stack panels

Panels with basic packing;

- Open the packing, at least partially

Panels without packing;

- Loosely covered with polythene
- Ensure that there is sufficient air circulation

Check regularly for any condensation during storage.

Panels with seaworthy or similar packing with internal protective covers

- Store the transport units
 - a. Protected from the weather
 - b. In a dry place
 - c. Safe from any damage
- Check the packing for damage
- Check the drying agent;
 - d. On arrival of the consignment
 - e. Subsequently at regular intervals

When the maximum storage period (starting from the date of packing) has been exceeded

- The protective function of the packing can no longer be guaranteed
- Take suitable action if intermediate storage needs to be continued



Warning

Do not walk on the top of the panels (due to rupture points in pressure relief devices) ! The pressure relief devices can be damaged!

Installation of Switchgear

In order to obtain an optimum installation sequence and ensure high quality standards, site installation of the switchgear should only be carried out by specially trained, or at least by supervised personnel and monitored by responsible persons.

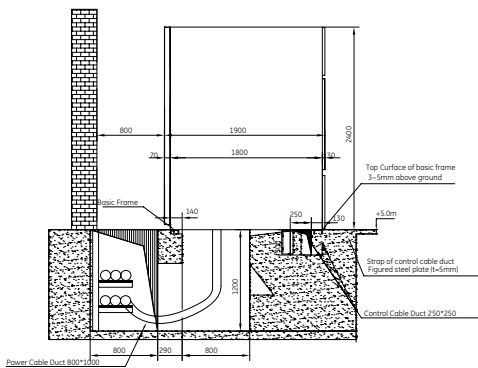
On commencement of installation on site, the switch-room must be fundamentally finished, provided with lighting and the electricity supply, lockable, dry and with facilities for ventilation. It is also required that the basic frame and indoor ground for the switchgear should be checked and accepted before the construction. It must be ensure that the ceiling height is sufficient for the opening travel of the pressure relief plates.

Tolerances for laying the floor frame are:

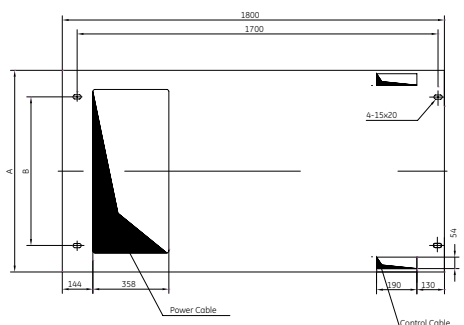
Evenness tolerance: $\pm 1\text{mm}$ within a measuring length of 1m.

Straightness tolerance: 1mm per 1m, but not more than 3mm over entire length of frame.

Cross section view of switchgear room layout (plan view)

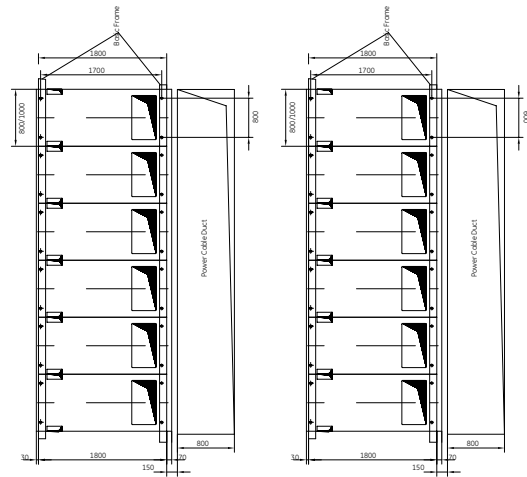


Detail of switchgear cable access cutout



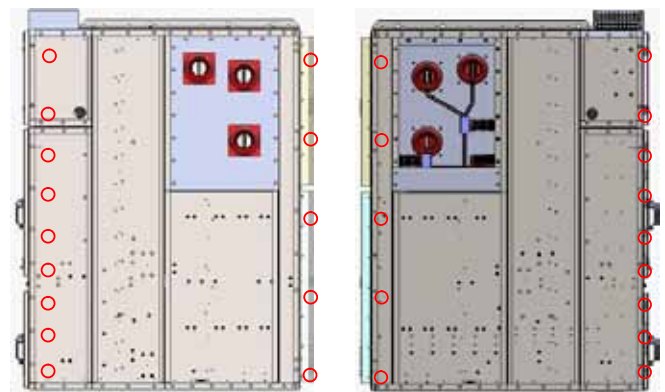
Width	Dimension	
A	800	1000
B	600	800
C	595	692

Switch room cable duct arrangement (Side elevation)



Connection between Switchgears

In order to connect the different switchgears together, here use bolts of $M8 \times 35$ to connect the panels together, the torque requirement for the bolts is 26 N·m, the connection points on the switchgear is shown below.



Connection Points between Switchgears

Technical Specification

Technical specification for SecoGear -Table 1

Rated voltage	kV	24	27
Rated power frequency withstand voltage	kV	50	65
Rated lightning impulse withstand voltage	kVp	125	125
Rated frequency	Hz	50/60	
Rated current	A	1250/2500	
Rated short time withstand current(3s)	kA	31.5	
Rated peak withstand current(1)	kAp	82	
Resistance	$\mu\Omega$	≤ 110 ($\leq 1600A$)	
		≤ 85 ($\geq 2000A$)	
IP level for weather protection	Enclosure	IP4X	
	Between compartment	IP2X	

Technical specification for SecoVac VB2 Plus (Circuit breaker) -Table 2

Rated voltage	kV	24	27
Rated power frequency withstand voltage	kV	50	65
Rated lightning impulse withstand voltage	kVp	125	125
Rated frequency	Hz	50/60	
Rated current	A	1250/2500	
Rated short-circuit breaking current:	kA	31.5s	
Percentage of DC component		Up to 52%	
Rated short-circuit closing current	kAp	82	
Rated short time withstand current	kA	31.5	
Rated peak value withstand current	kAp	82	
Rated duration time for short-circuit	s	3	
Opening Time	ms	20 ~ 50	
Closing Time	ms	30 ~ 70	
Rated auxiliary control voltage	V	24*/30*/36/48/60/110/220 V DC 110/220 V AC	
Operation sequence:		O-0.3s-CO-15s-CO/ O-0.3s-CO-180s-CO	
Mechanical life operations:	Times	10000 (M 2)	
Electrical Endurance	Class	E2	
Single Capacitor Switching current	A	400	

*Consult with GE

Main circuit resistance of SecoVac VB2 plus -Table 3

Item	Unit	Value	
Rated current	A	1250	2500
Withdrawable	$\mu\Omega$	≤ 45	≤ 25

Technical specification for Earthing switch -Table 4

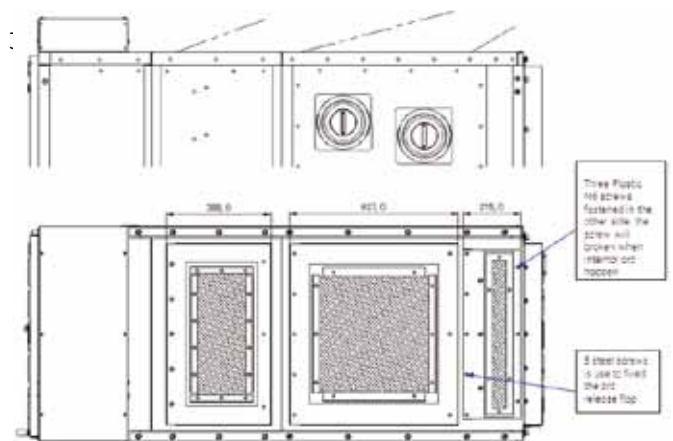
S/N	Specification	Unit	Data
1	Rated voltage	kV	24/27
2	Rated Work frequency withstand voltage (1min) in open condition of switch	kV	65
3	Rated Lighting impulse withstand voltage (peak value) in open condition of switch	kVp	125
4	Rated short-time withstand current (3s)	kA	31.5
5	Rated peak value withstand current	kAp	82
6	Rated short circuit making current	kAp	82
7	Centre distance between phases	mm	220/255
8	Electric endurance	Class	E1
9	Mechanical endurance	Times	2000

Resistance to internal arc faults

Arc release

All three primary compartments of SecoGear switchgear are provided with pressure relief flaps, which will automatically open and guide the pressurized gas to the rear side direction if an internal arc fault occurs in an affected compartment.

The pressure relief protects damage to switchgear components and the risk of injury to personnel, which may endanger an operator or extend the arc fault effect to the entire switchgear lineup. The relief flap is fixed by 3-M8 steel bolts and the other side is fixed by plastic M6 screw. The M6 screw will be broken and flap will open along weakness area(No bend area and part with oblong holes) when pressure increase quick by internal arc



Keylock (Optional)

The use of key interlocks is to realizing the interlocking logics between units of switchgear. Also the functional truck can be locked in the racked-out position and the relevant lock key can only be removed with the functional truck in disconnect position. The earthing switch closing and opening operations can be locked by means of keys. The latter can only be removed with the earthing switch in an opposed position to the lock to be made.

Description of the interlock system	Key Condition
Functional truck racking-in lock	Key will be free when the truck in the disconnect position
	Key will be trapped when the truck in the rack-in position
Earthing switch closing lock	Key will be free when the Earthing switch is open
	Key will trapped when the earthing switch in closed position
Earthing switch opening lock	Key will be free when the Earthing switch closed
	Key will trapped when the earthing switch in open position

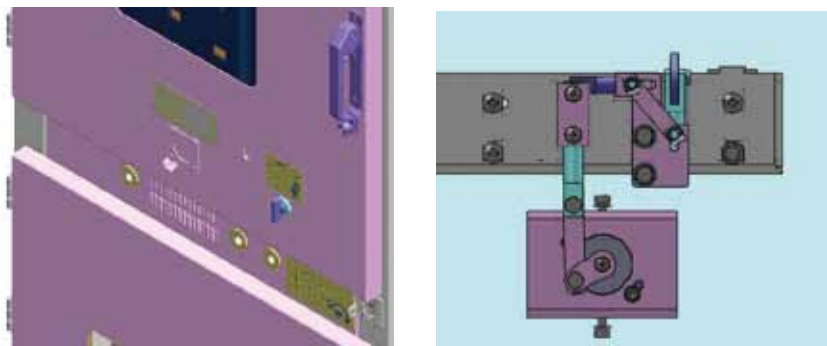


Figure : Functional truck racking-in lock

Key lock is locked, key is free, Truck indisconnect position

Key lock can't be locked when truck in rack in position, and key is trapped

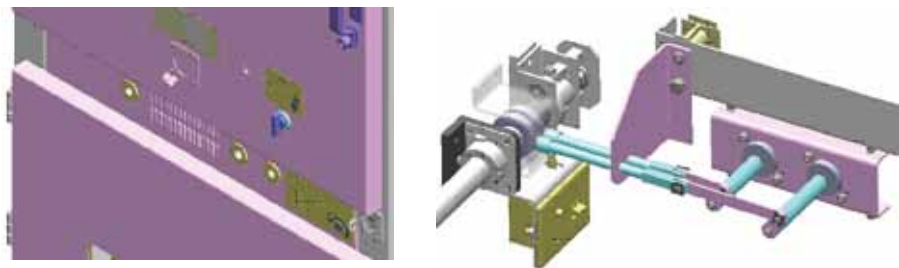


Figure 2/5: Earthing switch in open position

When earthing switch in open position, earthing switch can be locked by closing lock, the key of closing lock can be free. And opening lock can't be locked, the key of opening lock is trapped.



Figure 2/6: Earthing switch in close position

When earthing switch in close position, earthing switch can be locked by opening lock, the key of opening lock can be free. And closing lock can't be locked, the key of closing lock is trapped.

Padlock (Optional)

Padlock for Circuit breaker racking-in/out operation

Padlock for Circuit breaker racking-in/out operation will limit the access to insert crank lever to racking-in/out Circuit breaker. Racking-in/out operation can be done only when lock cover is in the open position.



Figure 2/9: Padlock for Circuit breaker racking-in/out operation

Padlock for earthing switch operation

Padlock for earthing switch operation will limit the access to inserting the operation lever to operate earthing switch. Open/close button can be operated only when the lock cover is in the open position.

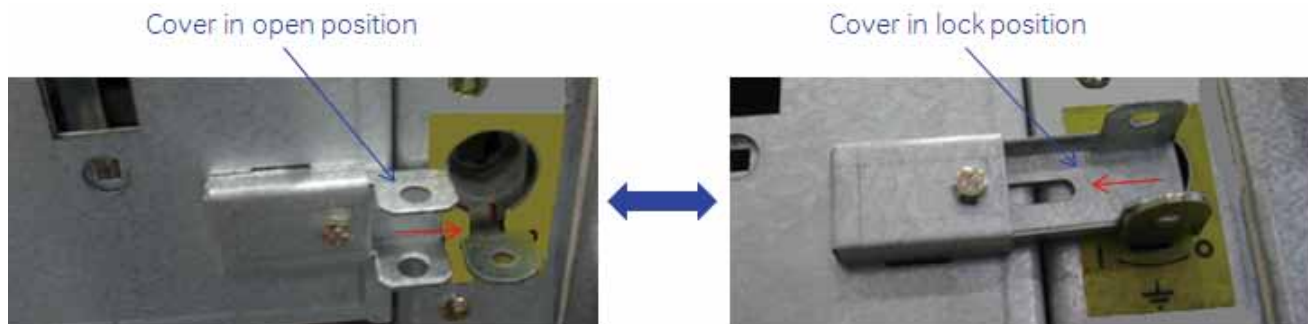


Figure 2/8: Padlock for earthing switch operation

Enclosure design and equipment

Typical modules (Figures 3/1)

With withdrawable type SecoVac VB2 Plus Vacuum Circuit Breaker installed, SecoGear panels are used for incoming or outgoing feeder. Each unit consists of three high voltage compartments; Main bus bar, Circuit breaker, Cable compartment and one Low voltage compartment for instruments and auxiliary circuits.

For busbar sectionalizing, two panels are necessary, the coupling panel with the withdrawable circuit breaker part and a bus riser panel (available with busbar metering and earthing). In equipment without busbar sectionalizing, a direct bar connection between the individual panels will be provided.



Figure 3/1: Typical modules

Enclosure and partitioning

High quality 2mm thick Alu-Zinc steel sheets is used for the external enclosure and internal partitions. Pressure relief flaps are provided on the top of the panel for all high voltage compartments. In case of overpressure due to internal arc inside any of the compartments, these pressure relief flaps are designed to open quickly to release the pressure. The pressure-relief flaps are secured with steel screws on one side and with plastic screws on the other side. In the case of internal overpressure, the plastic screws are the point of rupture caused by arc conditions. The top mounted pressure relief flaps on the enclosure are made from mesh metal.

All compartments are accessible from the front, with their own independent doors. The front doors can be opened up to an angle of 130° and they are arc resistant. An inspection window made of security glass is provided on circuit breaker compartment door. The panel design provides an air gap between two adjacent panels after panels are joined together.

- Figures of the panel (Refer to figure 3/2), the floor of the cable compartment is fitted with removable non-magnetic metal (13).
- The rear wall of the busbar compartment (3), intermediate wall (14), mounting plate with shutters (16) and horizontal partition (20) form part of the internal partitioning.
- The earthed internal partitioning ensures safe access to the circuit breaker and cable compartment (C) even when the busbars are energized.
- The low voltage compartment (D) is fully protected from the high voltage area with the earthed steel-sheet casing.
- On the end sides of the switchgear, end cover plates are provided for consistent appearance, as well as mechanical and thermal strength in case of internal arc fault in the end panel.
- Doors, rear walls and cover plates are treated against corrosion and then coated with high quality paint. The doors for circuit breaker and cable compartment are arc resistant with a mechanical interlock.

Switchgear structure

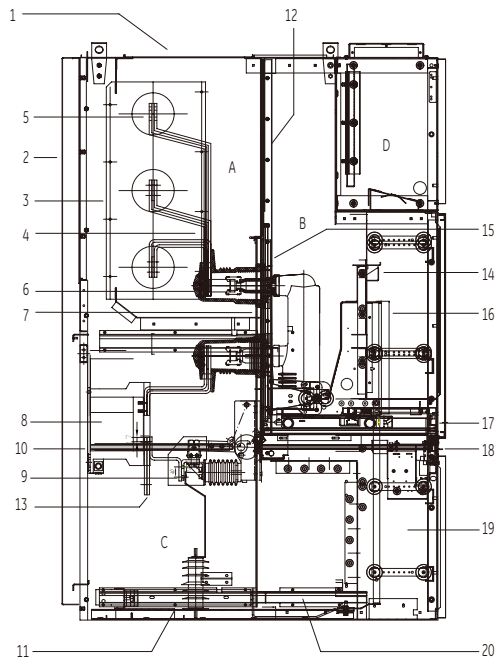


Figure 3/2: Typical feeder panel

- A. Main bus compartment
- B. Breaker compartment
- C. Cable compartment
- D. Low voltage compartment

- 1. Pressure relief plate
- 2. Enclosure
- 3. Cover of main busbar compartment (can be removed)
- 4. Branch busbar
- 5. Main busbar
- 6. Primary disconnect spouse
- 7. Primary disconnect
- 8. Current transformer
- 9. Earthing switch
- 10. Rear door interlock
- 11. Bottom plate
- 12. Partition between breaker compartment and busbar compartment
- 13. Terminal block
- 14. Control plug
- 15. Shutter
- 16. Vacuum circuit breaker
- 17. Drive screw
- 18. Earthing switch operation mechanism
- 19. Control wire duct
- 20. Main earthing busbar

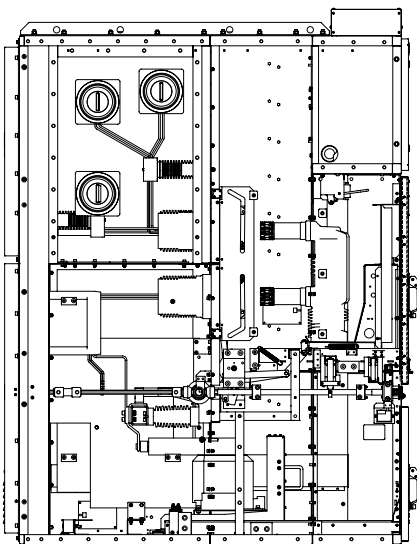


Figure 3/3: Incoming/feeder panel (1250/2500A)

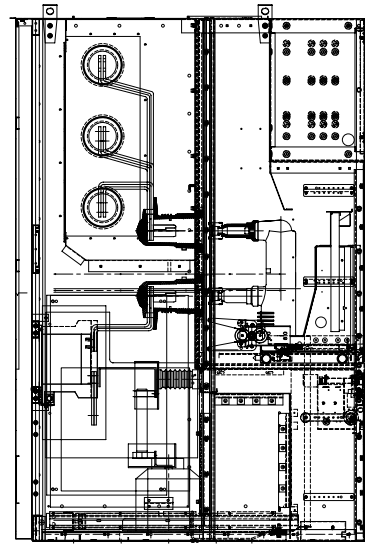


Figure 3/4: Incoming With fix VT panel (1250/2500A)

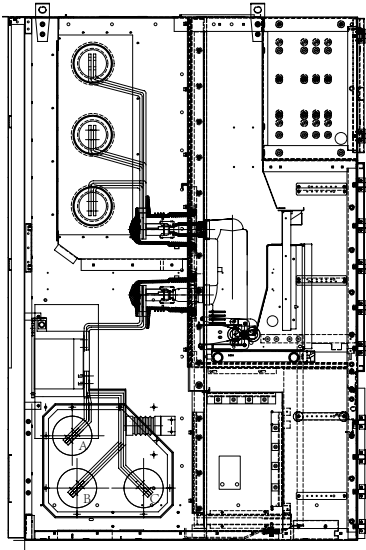


Figure 3/5: Busbar tie panel(1250/2500A)

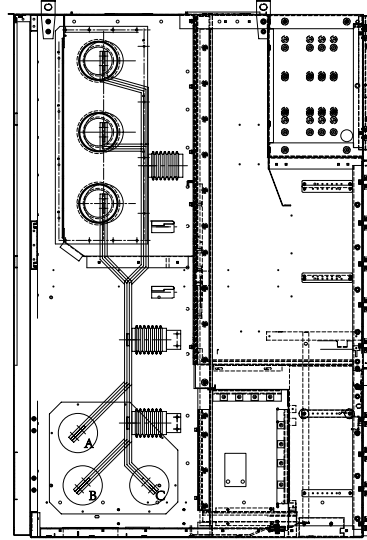


Figure 3/6: Riser panel(1250/2500A)

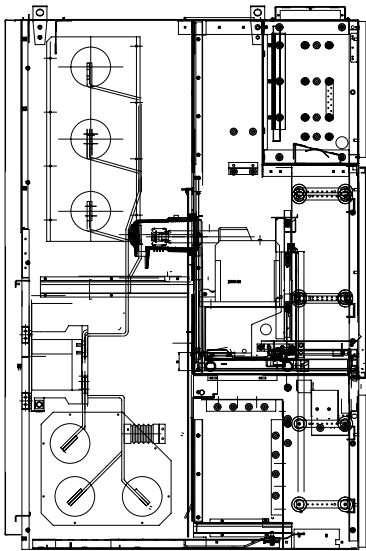


Figure 3/7: Measuring panel(1250/2500A)

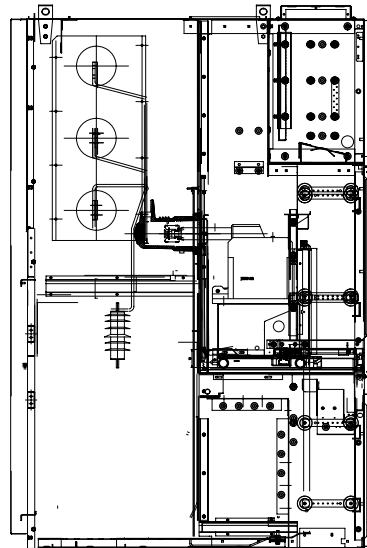


Figure 3/8: VT Panel (2500A)

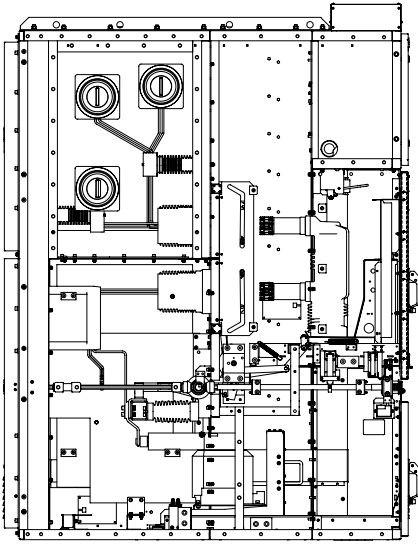


Figure 3/9: Incoming with ES & VT panel (1250/2500A)

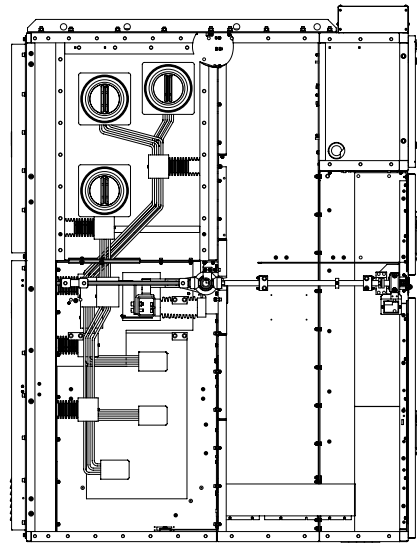


Figure 3/10: Riser with ES panel (1250/2500)

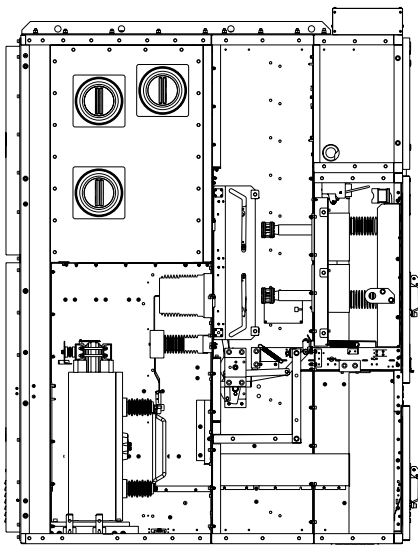


Figure 3/11: CPT panel (2500A)

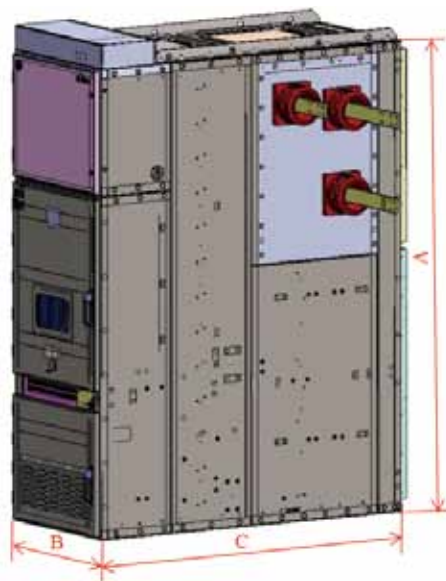


Figure 3/12: Typical dimensions and Weights of SecoGear (including withdrawable circuit-breaker parts)

Description			Dimension in mm
			27kV
Height		A	2400
Width	Rated current of branch 1250A 31.5kA	B	800
	VT		
	Rated current of branch 2500A 31.5kA		1000
Depth		C	1800

Rated current	Weight
A	Kg
1250	800-1000
2500	1000-1200

Cable Connections

The cable compartment contains current transformers, voltage transformers (fixed or withdrawable), and earthing switch, depending on the individual operating requirements.

The cable compartment is constructed for installation of three current transformers. When all the three current transformers are not required, dummies can be installed in their place to maintain the same installation and connection procedures.

The fixed or withdrawable voltage transformers are connected with busbar on the primary side and fitted with HRC fuses. The earthing switch can be operated manually, with position indication by mechanical indicator on the driveshaft and auxiliary switch. Three lightning arrestors (optional) can be mounted in the space available.

Cable connection:

Rated voltage (kV)	Panel width (mm)	Max. number of parallel cables per Phase	Max. cross section of cables (mm ²)	Range of cable clamp (mm)	Range of reducer ring (mm)
27	800	6	630	35-54	27-62
	1000	6			

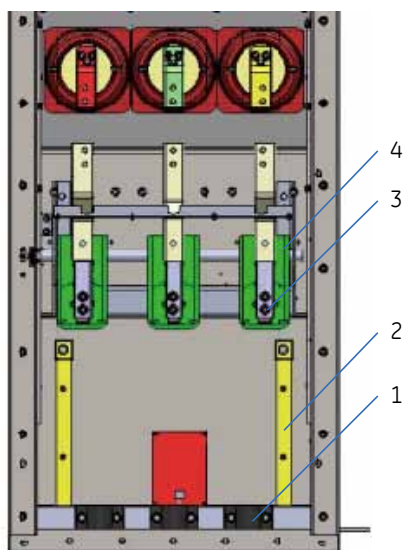


Figure 3/13: Cable compartment layout

NO.	Parts Description
1	Cable clamp
2	Main earthing bar
3	Cable connection bar
4	Earthing Switch

CAUTION

This cover has been interlocked with the earthing switch and can be opened only when the earthing switch is in closed position
Earthing switch can be opened only when rear cover is closed

Operations and trouble shooting

Operations and trouble shooting

Before start up, the following work should be completed:

- a. Check the overall condition of the switchgear and clear any potential risk factor.
 - b. Check the switch, truck, isolated contactor and insulating parts etc. by visual inspection.
 - c. Check the connection between earthing bus bar and earthing conductor of the transformer substation outside the compartment is secure.
 - d. Remove all of the remaining materials, unnecessary objects and tools inside of the compartment.
 - e. Wipe the compartment body and the insulation parts with a soft cloth that should be clean and dry. Then wipe off any remaining dust and grease.
 - f. Clean the surface of earthing busbar. The earthing loop resistance should be less than 350 micro-ohms.
 - g. Re-install the cover removed during the period of installation, wiring and commissioning.
 - h. Remove the shipping cap on the pole of the circuit breaker.
 - i. When testing the power frequency withstand voltage of main circuit, pay particular attention to sensors, cables and other equipment during the test process.
- Attention:** Read the product manual carefully when testing the VT withstand voltage; use a test voltage of appropriate frequency to avoid core saturation.
- j. Place the Circuit Breaker on auxiliary control power.
 - k. Perform the operation test of the circuit breaker by manual or electric control; observe the corresponding position indicator.
 - l. Check the interlocking validity, both mechanical and electrical.
 - m. Conductive paste can be applied on the circuit breaker primary contacts.



Warning

- a. Comply with all relevant safety regulations
- b. Maintain circuit breakers in disconnection position
- c. Remove earth wires and short wires of the hazardous areas
- d. Pay attention to any abnormal situations

Use of hand tools

1) Gear door lock key
drawing no: 5GD.253.008



2) Rack handle for truck
drawing no: Y-002



3) Earthing switch operation handle
drawing no: 5GD.253.144

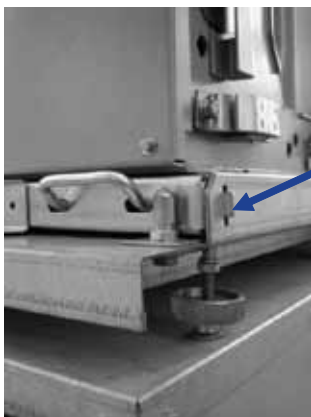


FIG 20 : Hand Tools

Rack Circuit Breaker out from service position to test / disconnected position

Move circuit breaker truck from transfer truck into the switchgear

- a. Check the fixed primary contact and apply an adequate amount of conductive paste. Check the interlocking mechanism and apply lubricant on the moving parts to ensure smooth operation.
- b. Place the Circuit Breaker on transfer truck and put in lock position. (See figure 4/1).



VCB locked on the transfer truck

Figure 4/1: VCB truck on the transfer truck

- c. Move the transfer truck to the front of the switchgear, turn the adjusting nut to adjust the height of the transfer truck platform, (See figure 4/2). Aim the guiding pin at the guiding jack in front of the switchgear, push and make the transfer truck engage with the switchgear by using the lock key. At the same time, insert the front guide rail of the transfer truck into the bottom guide rail groove of the switchgear truck. (See figure 4/3).



Figure 4/2: Transfer truck lock with switchgear



Figure 4/3: Lock VCB in switchgear



Warning

The trolley has four (4) nuts for adjusting the platform, to the same level of the breaker compartment.

- d. Push the two sliding cranks inward under the truck to remove the locked position with the transfer truck, and then push the truck forward to make it enter the switchgear compartment and lock it in the disconnect / test position. (See figure 4/4).
- e. Operate the lock key releasing lever of the transfer truck to



Figure 4/4: Lock VCB in switchgear

remove the locked relation between the transfer truck and the switchgear, and then remove the transfer truck.

Move the truck from disconnect / test position to service position

- a. Make sure the front and back door of the switchgear are closed. Make sure the earthing switch is in the open position, the circuit breaker compartment is clear and without any unexpected object.
- b. Insert the secondary plug of the truck into the socket on the topside of the switchgear truck compartment and put into the lock position. (See figure 4/5 & 4/6)



Figure 4/5: Take off secondary plug from truck



Figure 4/6: Put the secondary plug into switchgear socket

- c. Make sure the circuit breaker is in the open position.
- d. Insert the racking crank of the truck into the rectangular cranking hole of the screw mechanism of the truck through the operation hole under the door of the circuit breaker compartment. (See figure 4/7).



Figure 4/7: Rack in the breaker to work position

- e. Turn the crank clockwise (approximately 20 turns) until it can't be moved any more, listen for a strong cranking sound when the breaker changes into the operating position.
- f. The position indicator on the door of the low voltage compartment shows the breaker is in service position.
- g. Take off the racking crank. The racking operation is now complete.



Warning

The truck is not allowed to be placed in any intermediate position between disconnect/test position and operating position.

Move the Circuit Breaker from service position to test position

- a. Make sure the circuit breaker is in open position.
- b. Perform the operating steps for moving the Circuit Breaker into operation position in reverse order.

Move the Circuit Breaker from switchgear compartment to transfer truck.

Perform the operating steps for moving the Circuit Breaker truck from transfer truck into the switchgear in reverse order.

Circuit breaker

For operating instructions refer to the Circuit Breaker instruction manual.

Earthing switch operation

The earthing switch has a rapid close-open mechanism, which is independent to the rotation speed of the earth switch drive shaft.

The closing brake function can be quickly applied through the rapid close-brake mechanism. The earthing switch, circuit breaker truck and rear cover behind the panel have a closedown device to prevent incorrect operation.

The earthing switch can be operated only when the truck is in disconnect / test position and the rear cover of the switchgear is in the closed position.

The operating hole of the earthing switch located in the lower position of the right side in front of the panel. (See figure 4/8).

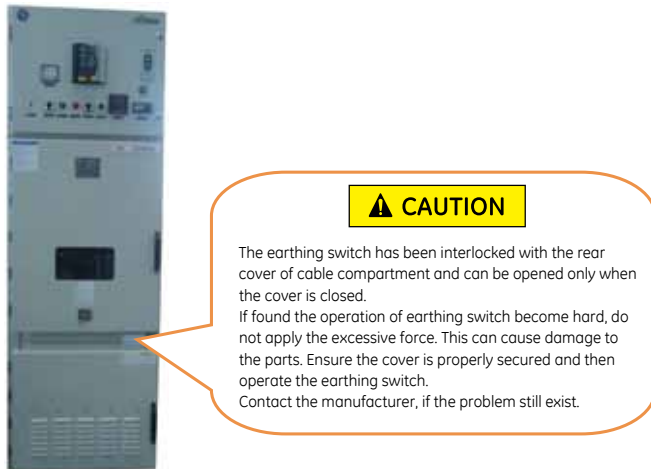


Figure 4/8: Earthing switch operation warning

Close the earthing switch

- Check that the voltage presence indication on the low voltage compartment is off.
- Check other electrical interlock, if applicable, to allow the operation.
- (See figure 4/9) Lower the operating hole shutter and insert the operating handle, and turn the handle 180° clockwise to close the earthing switch.



Figure 4/9: Close earth switch

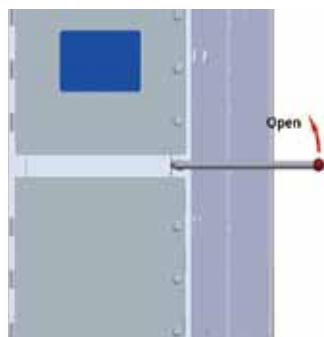


Figure 4/10: Open earthing switch

- Ensure the earthing switch is fully closed.

Warning

Check the position indicator on low voltage compartment door
Check the flag adjacent to the earthing switch operating hole

Open the earthing switch

Warning

Make sure the cable compartment is clear and without any unexpected objects
Make sure the cable compartment door is closed completely

- Insert the earthing switch operating handle, and turn the handle 180° counterclockwise to open the switch (See figure 4/10)
- Check the mechanically interlocked label and indication light to ensure the earthing switch is fully open

Interlocking of the switchgear

- The circuit breaker can be closed only when fully engaged in the test or service position
- The control plug can be released when the circuit breaker is in test or disconnected position. The secondary plug is latched when the circuit is in service position (see figure 4/11)



Figure 4/11: Secondary plug latch

- Front Break is released only when operating lever is inserted; and operating lever cannot be inserted when undercarriage is in test position
- Undercarriage Interlock is released only when undercarriage is in test position
- Undercarriage and ES interlock insures undercarriage can be in service position only when ES is OFF
- Back Break insures ES can be switched only when back door is closed
- Back Door Interlock is released only when ES is ON

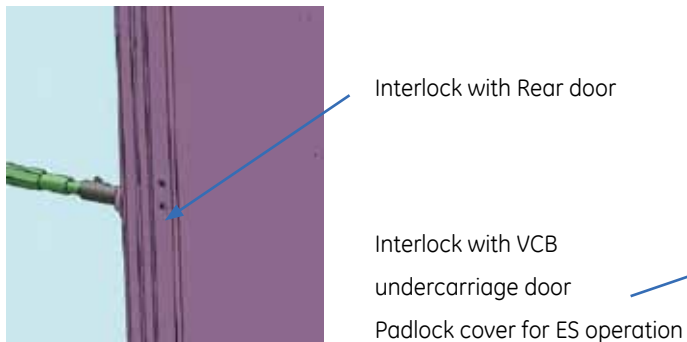


Fig 4/12 Earthing switch interlock with rear cover

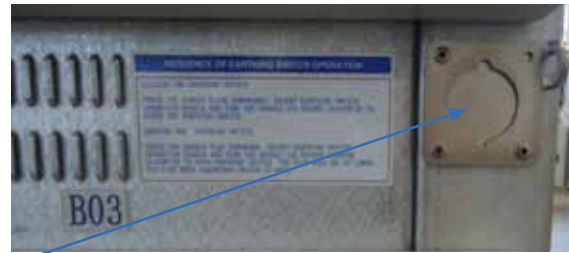


Fig 4/13 Breaker interlock with undercarriage

SEQUENCE OF EARTHING SWITCH OPERATION

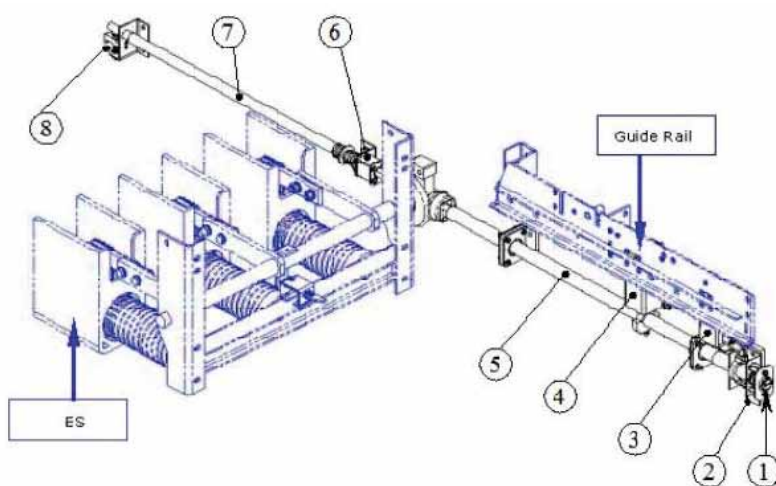
Closing the earthing switch:

Press the handle slide downwards; insert earthing switch operation handle and turn the handle 180 degree clockwise to close the earthing switch,

Opening the earthing switch:

Press the handle flap downward, insert earthing switch operation handle and turn the handle 180 degree counter clockwise to open earthing switch.

The flap will be in lower position when earthing switch is open



1. Operation Lever Insert Socket
2. Front Break
3. Undercarriage Position Interlock
4. Undercarriage and ES Interlock
5. Front Operation shaft
6. Back Break
7. Back Interlock Shaft
8. Back Door Interlock

Fig 4/14: Earthing switch interlock VCB truck and Rear door

Inspection and maintenance

Summary

After the process of installation and testing, the switchgear is available to use. Timely and proper maintenance can keep the switchgear trouble-free and can prolong the life of the switchgear as long as possible.

The maintenance work must be carried out by certified persons who are familiar with the related operations of the switchgear and understand relevant IEC and other local safety rules and important guides established by other technical departments as well. Allow a GE representative to assist when the switchgear and its components need to be repaired. Users should think about the operating environment and the operation frequency when developing maintenance rules. Usually the inspection of some equipment / components (such as wearable parts) and the maintenance intervals (maintenance period) depend on the running time, operating frequency and the number of short circuit cycles. The maintenance period of other parts depends on the working situation, the degree of the load and environmental impact (including pollution and corrosive gasses).

Inspection and maintenance interval

The maintenance interval determined by operating conditions of the switchgear depends on the operating mode, the operating number of rated current and short circuit current, environment temperature and pollution.

The recommending maintenance interval is showed in the following table:

maintenance content	interval(years)	according to the operation cycle of circuit breaker
inspection	2~3 ¹⁾	5000 ³⁾
care and maintenance	2~3 ²⁾	

- 1) Recommended shorter interval years when operated in very severe running conditions.
- 2) According to inspection results.
- 3) Refer to the VCB manual.

Diagnosis and trouble shooting for malfunction during operations

Malfunction	Reason	Resolution
The circuit breaker can not be racked into service position from test position	<ol style="list-style-type: none"> 1. The handles on the withdrawable frame is not in position. 2. The circuit breaker is closed 3. The earthing switch is closed 4. The circuit breaker is electrically interlocked (electromagnetic Y0 locked) 5. Shutter is not completely open 	<ol style="list-style-type: none"> 1. Adjust the frame and handles 2. Open the circuit breaker 3. Open the earthing switch 4. Unlock /Check electromagnetic Y0 5. Check shutter drive mechanism
The circuit breaker can not be racked out to test position from service position	<ol style="list-style-type: none"> 1. The circuit breaker is closed 2. The circuit breaker is electrically interlocked (electromagnetic Y0 locked) 	<ol style="list-style-type: none"> 1. Open the circuit breaker 2. Unlock /Check electromagnetic Y0
Can not lower the shutter on the earthing switch operating hole	<ol style="list-style-type: none"> 1. The circuit breaker is not in test / disconnected position 2. The earth switch is electrically interlocked 	<ol style="list-style-type: none"> 1. Rack the circuit breaker out to test position or disconnected position 2. Unlock / Check electromagnet
Operating hole shutter can not rise back after the earthing switch is opened	Drive shaft of earthing switch has not reached intended position	Turn the crank anticlockwise to the limit where the mechanical OPEN indication stays exactly below the operating hole
The cable compartment door can not be closed / opened	The earthing switch is not completely opened	Open the earthing switch
The circuit breaker can not be closed	<ol style="list-style-type: none"> 1. No auxiliary power supply 2. The control plug is not inserted 3. The circuit breaker is not engaged in test / service position 4. The closing spring has not been charged 5. The electrical interlocking in position 6. Closing release not working 	<ol style="list-style-type: none"> 1. Turn on auxiliary power supply 2. Insert and lock control plug 3. Fully engage the circuit breaker to test /service position 4. Charge the closing spring 5. Check power supply for interlocking 6. Check power supply for closing release
The circuit breaker can not be opened	<ol style="list-style-type: none"> 1. No auxiliary power supply 2. Opening release not working 	<ol style="list-style-type: none"> 1. Turn on auxiliary power supply 2. Check power supply for opening release

Maintenance item and cycle



Maintenance of the switchgear should be carried out by trained personnel, who are familiar with the switchgear characteristics, in accordance to the manufacturer's instructions and IEC standards.

It is recommended any major repairs (if required) shall be assisted by the manufacturer or a qualified representative.

Routine Inspection



Safety measure: Routine inspection is to ensure smooth operation of the switchgear. It does not require power shutdown, but requires care to prevent incorrect operations.

The purpose for routine inspection is to find issues in advance so they can be resolved immediately.

Routine inspection includes:

- Check compartment doors are closed properly
- Verify the control voltage, auxiliary voltage and battery voltage are in normal condition
- The status indication and position indication for the circuit breaker and earthing switch etc are normal
- Check ammeter and voltmeter on the display
- Check relay indications. (The power indication should be on and fault indication should be off.)
- Check alarm and pre alarm indications
- Partial discharge should not occur on the surfaces of equipment at operating voltage. This can, for example, be detected by characteristic noises, a clearly perceptible smell of ozone, or visible glowing in the dark;
- Check the heater condition, if installed. The relay monitoring the heater current is in the low voltage compartment. Check the heater circuit if the red current indication turn off due to the heater losing power supply. (see figure 5/1)

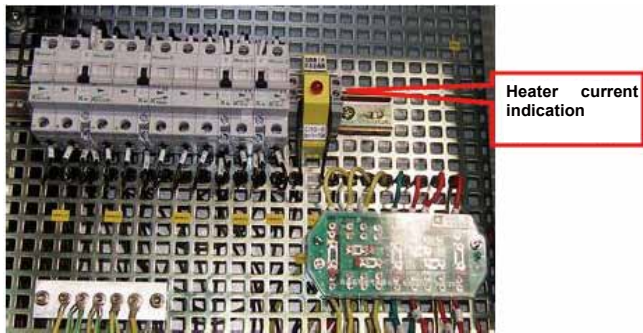


Figure 5/1: Heater current monitoring relay

If any abnormal condition is found, then the cause must be identified in order to restore normal condition.

Service



Safety measure: The power must be shutdown before scheduled switchgear service, and the work area must be isolated. Measures must be taken to disallow the power being switched on. Ensure proper earthing and padlocks in place. Specially trained personnel are required to supervise.

The purpose for the service is to guarantee the operation quality of the switchgear and avoid any possible malfunctions. This increases the life of the switchgear. The scope of work is as follows:

- Inspection: Determination of the actual condition
- Servicing: Measures to preserve the specified condition
- Repair: Measures to restore the specified condition

The service interval for the switchgear depends on external factors including the operating environment, the operation frequency and service age etc.

It is recommended to have switchgear serviced every 2-3 years, if installed in good environment and not frequently operated.

It is recommended to have switchgear serviced every year, if operated more than 10 times a month.

It is recommended to have switchgear serviced every half year, if installed in adverse environment and frequently operated.

It is recommended to have the circuit breaker replaced, if reached its mechanical operating cycles or rated short circuit breaking times.



It is recommended to inspect the circuit breaker every 6 months if in stand-by for a significant period of time.

Repairs

Immediate repairs are required in case of following situation emerges:

- Deteriorated insulation, discharges, flashover and breakdown
- Damaged component in the switchgear
- Any other abnormal observation which may affect safety

Inspection Items

- Check all the compartments and internal components for dampness, rust and dirt.
- Check the tightening torques of the busbar bolted connections on selected samples.
- Remove the pressure flaps on the busbar compartment and remove the insulation shield (See fig 5/2). Check the torque is 86 N-m using a torque wrench.
- Check the fixed contact including its profile for any sign of sparking or wear-and-tear.
- Check the shutter mechanism in the circuit breaker compartment.
- Check the interlocking between the circuit breaker and the earthing switch.
- Check the bolted connection between the power cable connectors and lugs.
- Check earthing switch operation.
- Check the interlocking between the earthing switch and the cable compartment door.
- Check the interlocking between the circuit breaker and the breaker compartment door.
- Check live voltage indications.
- Check the heater (If installed).

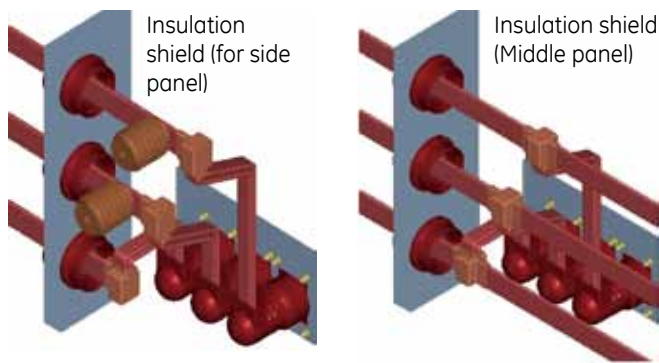


Figure 5/2: Main busbar shield(Need to be replaced)

Performance test

Performance test is to validate the electrical performance of the switchgear. It is recommended to be carried out together with the scheduled service.

Performance test includes:

- Close and open the circuit break for five times, and check the circuit
- Check all the interlocking mechanism
- Electrical test including power frequency withstand test, CT/VT ratio and the contact resistance for the circuit break
- Verify mechanical characteristics of the circuit break

Major Repairs and examples



Be sure to comply with the applicable safety regulations when carrying out repairs.

- Open the main busbar compartment and check the tightening torques for the busbar bolted connections
- Check the main busbar and branch busbar for any dampness or rust.
- Check all the sidewalls for any dampness or rust.
- Check the main busbar compartment for any unexpected object.
- Restore the insulation shield and the pressure flap on the top of the panel.
- Check the fitness of the fixed contact and the surface condition.
- Open the cable compartment and check the cable connection as well as the connectors for color distortion.
- Check the sealing condition of through holes for the primary and secondary cables.
- Check the heater condition.
- Check the breaker and cable compartment for unexpected objects.
- Check the secondary connections of the CTs.
- Check the current terminals in the low voltage compartment for the close loop of the secondary current circuit. Check the protection relay, ammeter, energy meter, etc. on the CT secondary are in service.

Inspection and replacement of the main busbar

Unexpected objects in the busbar compartment, or a loose bolted connection, may result heated joint or even phase fault.

The procedure to change the main busbar is as follow;



Verify the switchgear is de-energized and the safety measures are in place.

- Remove the rear covers on the busbar compartment, as well as the same on the adjacent panels. Now the busbar is visible. (see figure 6/1)

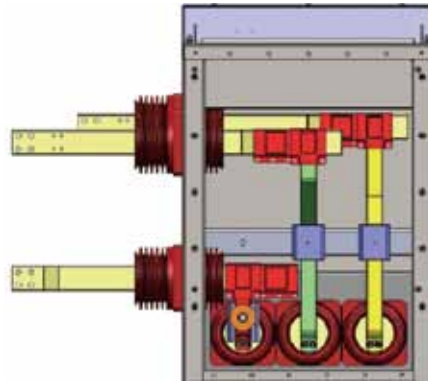


Figure 6/1: Busbar after opening the rear cover

- Remove the pressure flap on the busbar compartment
- Remove the busbar insulation shield
- Remove the connection bolt on the main bar and branch busbar
- Remove the busbar from the busbar compartment
- Install the new main busbar and fasten the joints



Pay attention to the direction of the tapered washers and the bolted connection torque should reach 86 N-m.

- Cover the busbar joints with insulation shield
- Reassemble the pressure flaps and rear cover panels for the busbar compartment

Inspection and replacement of the fixed contact and spout bushing

It is normal to find the fixed contact surface oxidized due to current flow and environmental factors during period of service. However if the surface becomes rusty due to wet or corrosive conditions, the fixed contact must be replaced. The spout bushing may be replaced depending of its condition.

Clean the contact with a cotton-free paper, and apply some pure alcohol if necessary. Brush small amount of contact lubrication grease (DE-G51 for example) on the surface after wiping. It is important to check any abnormal condition such as the burning marks on the spout bushing, which may be caused by the epoxy.

- Check and replace the fixed contact



Verify the switchgear is de-energized and the safety measures are in place.

- Withdraw the circuit break . Open the shutter mechanism, and insert two M8 bolts into the overlapping holes on the shafts (See figure 6/2). Then the fixed contact along with the spout bushing are visible.

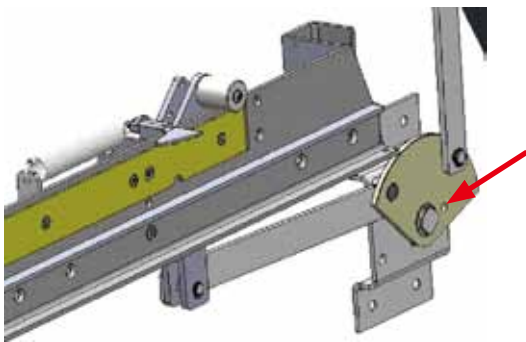


Figure 6/2 : shutter mechanism

- Inspect the contacts. Replace the contact if the silver coating on copper is worn, or the surface is corroded, damaged or over heated.
- Remove the bolts on the fixed contact, and replace the fixed contact (see figure 6/3)
- Replace the spout bushing
- Remove the bolt at the joint of the upper branch and main busbar
- Remove the bolt at the joint of the lower branch busbar and the current transformer
- Remove the center bolt of the fixed contact and then remove the vertical connections

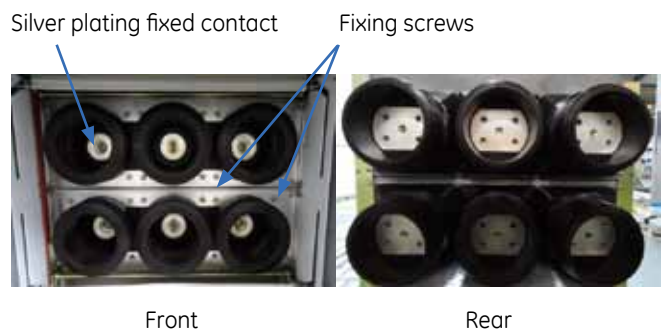


Figure 6/3: Fixed contact and spout bushings

- Remove four fixing screws (M12) of the spout and then the spout can be removed (see figure 6/3)
- Replace the new spout bushing and fasten the fixing screws (M12). Inject glass glue in the clearance between the spout bushing and the mounting metal frame
- Insert the upper and lower branch busbar into the spout bushing, and fix the fixed contact



Don't fasten the bolt initially when locking the fixed contact, Please fasten by applying torque when the upper branch and main busbar, lower branch and the current transformer are fixed;

Attention: The torque will be different based on different sizes of the bolt and with/without lubrication. Corresponding torques of different bolts identified below:

Bolt size	Recommend torque (N-m)	
	Without lubrication (oil)	With lubrication (oil)
M8	26	10
M10	50	20
M12	86	40
M16	200	80
M20	300	120

- Tighten the bolt on the upper branch and main busbar. Ensure that applied torque is 86 N-m
- Tighten the bolt of the lower branch busbar and the current transformer. Ensure applied torque is 86 N-m
- Remove the inserted bolts on the driving mechanism of the shutter, and then put down the shutters

Inspection and replacement of the shutter mechanism

In case of distortion or deformation, the driving mechanism of the shutter shall be replaced.

The steps as follows:

- Remove the split pins of the driving mechanism of the shutters and connection bar (see figure 6/5)
- Screw off the bolt which is used to fix driving mechanism (see figure 6/4)

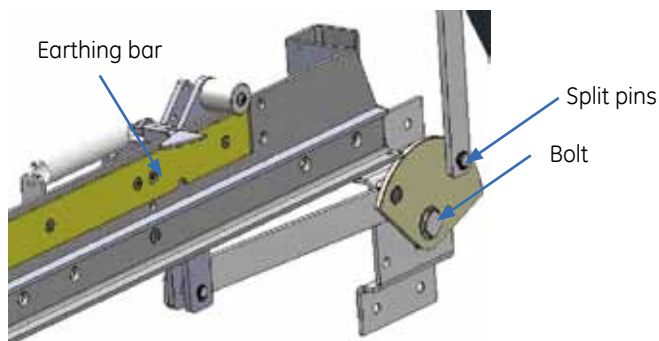


Figure 6/4: Driving mechanism of the shutter

- Remove the 5 screws on the earthing bar, then remove the earthing bar.
- Replace the 4 screws on the side plate of the shutter mechanism, then remove the side plate.
- Remove the 6 screws which used to fix the shutter mechanism, replace with the new parts of shutter mechanism.
- Now replacement can be done with the above instructions following the previous instructions in reverse order.

Replacing the earthing switch

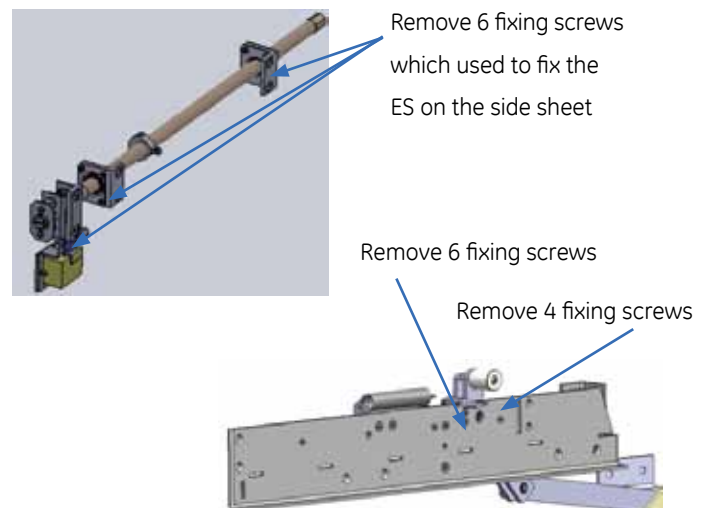
The replacing of the earthing switch includes changing the earthing switch along with labels for ON and OFF position, the driving mechanism including driving gear assembly and drive rod.

The steps for replacement are as follows.



Ensure switchgear is in Power OFF position and turn the earthing switch to the ON position.

- Rack out the circuit breaker
- Remove the compartment separating plate
- Remove the cover plate on the right side in the cable compartment



- Loosen the fastening screws on the drive rod, but do not remove completely.



Both the screws can be accessed only when the earthing switch is in OPEN position

- Open the padlock on the operating hole of the earthing switch
- Draw out the drive rod forward, then the parts of the drive rod in the switchgear can be removed from backwards now.



Attention: Don't fully remove the drive rod, otherwise all the parts will fall out.

- Completely draw out the drive rod from another side at a slight angle.
- Loosen the 4 fixing screws on the fixing bracket (see figure 6/6), and then remove drive rod of the rear door interlock from rear door, then draw out the drive rod backward.



Attention: Replace the bevel gear assembly and earthing switch in the same way. Use care to avoid damage as the main body is much heavier.

- Unscrew both of the bolts on the bevel gear (See figure 6/7).



Figure 6/7: Fixing screw of bevel gear

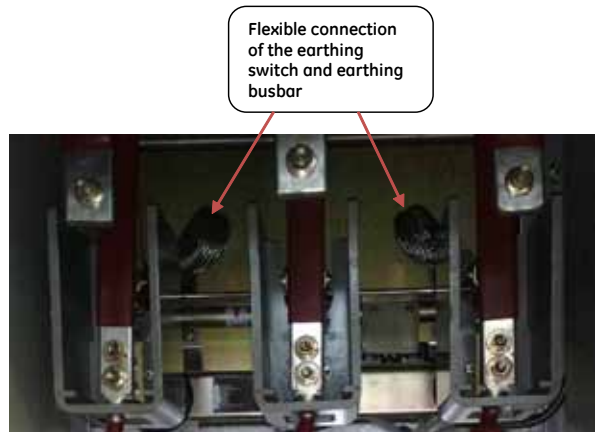


Figure 6/8: Flexible cable between earthing Switch and earthing busbar

- Unscrew the flexible connections between the earthing switch and common earthing busbar (see figure 6/8)
- Remove the fixing screw of the earthing switch, and then push the bevel gear and the main body of the earthing switch (See figure 6/9)
- Now replacement can be done with the above instructions following the previous instructions in reverse order.

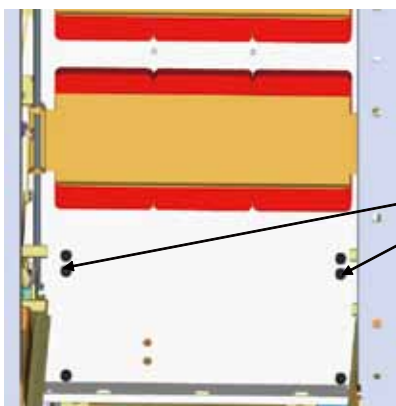


Figure 6/9: Fixing screw of the earthing switch

Replacing the current transformer

Replace the current transformer if the assembled current transformer cannot meet the function due to a change in the load conditions. The steps are as follows:



Confirm the equipment be powered off and make sure to follow proper safety measures.

Confirm the earthing switch is in OPEN position.

- Remove the back cover of the enclosure
- Remove the connection bolt between the current transformer and the vertical copper connections (See figure 6/10)

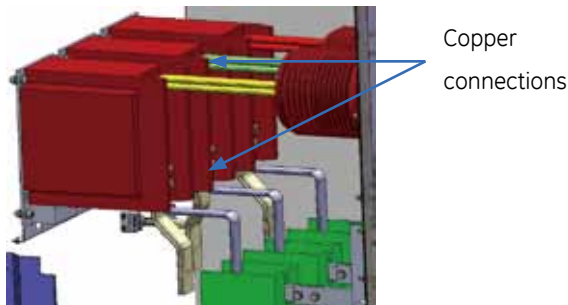


Figure 6/10: Connection busbar between current transformer and earthing switch

- Remove the secondary wires of the current transformer
- Remove the 6 pcs of M8 bolts on the mounting plate of the current transformer



Attention: The weight is heavy because of the current transformer installed in the mounting plate. It is necessary to hold the mounting plate of the current transformer to avoid the damage for the equipment and personnel if the mounting plate drops down after loosening the bolt.

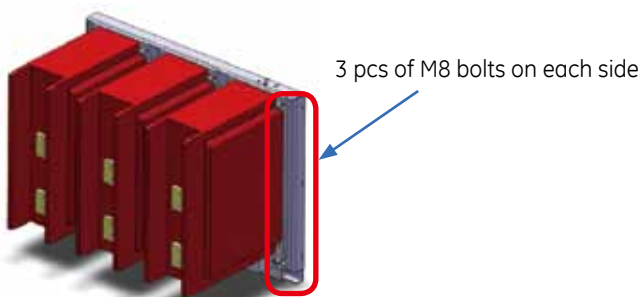


Figure 6/11: Mounting plate of the current transformer

- Support the mounting plate of the current transformer and then put on the ground
- Remove the four bolts which are used to fix the current transformer, and remove the current transformer
- Replace the current transformer with new one and screw on with the four bolts



Ensure the marking on the mounting plate for the installing position of the current transformer before removing the four bolts to avoid the wrong position with the hole of the copper connections after installing the new current transformer;

- Assemble the current transformer in its place on mounting plate and tighten the mounting plate by tightening the 10 pcs of M8 bolts
- Screw on the bolts on the current transformer and the both side copper connections
- Fix the bolt of the fixed contact of the earthing switch, but do not fully tighten.
- Adjust the position of the fixed contact after switching the earthing switch in ON Position and then fasten
- OPEN the earthing switch
- Fasten the bolts on the copper connections and the current transformer mounting with a torque wrench at a torque of 86 N-m
- Fix the insulation shield, and make sure it is in a vertical position
- Connect the secondary connection of the CT and cover it according to the requirements
- Assemble the back cover and compartment separating plate of switchgear

Inspection and replacement of the surge arrester

It is necessary to replace the surge arrester based on big difference between reference voltage and the test data recorded on site during the maintenance and recording. The steps are as follows:

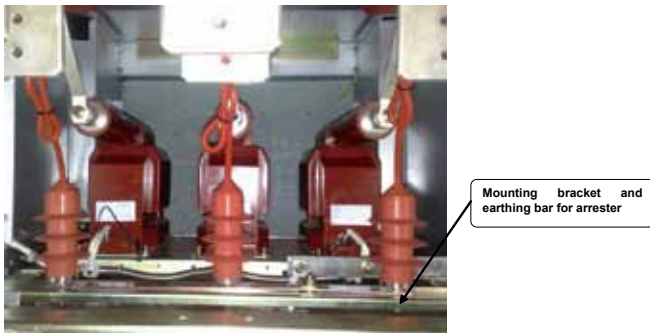


Figure 6/12: Installing surge arrester

- Remove the cable between the arrester and copper connection (See figure 6/12)
- Remove the fixed bolts on both sides of the mounting bracket of the arrester
- Push the three arresters and the bracket
- Remove the fixed bolts on the mounting bracket of the arrester

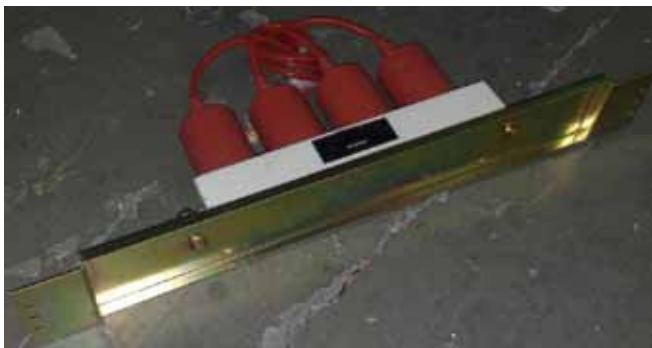


Figure 6/13: Surge arrester mounting plate

- Install the new arrester and fasten the bolts with the mounting bracket
- Screw both side bolts on the brackets
- Fix the connection between the arrester and copper connection

Inspection and replacement of potential indicator

If the display "Lock" on the potential indicator is flashing, and an abnormal sound from the relay is continuously heard, there may be two reasons that can cause this problem. First, there may be a problem with the potential indicator contact. Second, the display itself may have a fault despite three-phase power condition.

Both of these situations demand to replace the display. The steps are as follows:

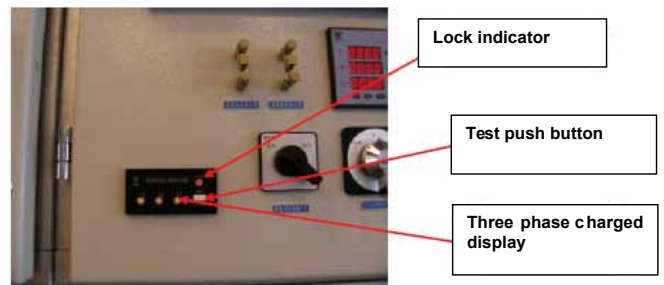


Figure 6/14: Potential indicator

There are two types potential indicators. One is with latching contact, and another is without the latching contact. The replacement of the two types are the same. (See figure 6/14)

- Cut off the auxiliary power of potential indicator (if any)
- Disconnect all the connection from the back of the indicator
- Remove the lock of the potential indicator, and then push it out (See figure 6/15)
- Replace with the new one, and fix the lock
- Reconnect the wires at back
- Recover the auxiliary power

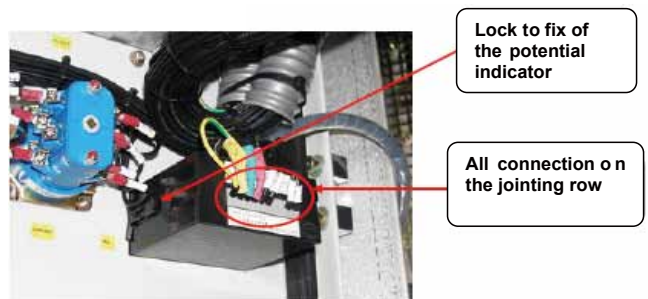


Figure 6/15: Removing and installing for the potential indicator

Main Busbar

Rule and Note:

Every 3~4 panels use one Main Busbar. The maximum length of Main Busbar should be less than 4m.

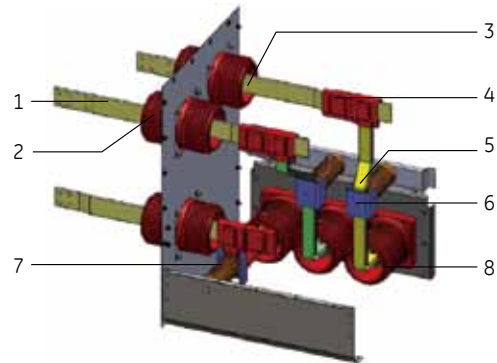
Below is a table indicating Busbar sizing;

	Rated current	Busbar type	Cross section (copper)
Main Busbar & Branch Busbar (Rectangle)	1250A	Branch	50×8×2
		Main	80×10×1
	2500A	Branch	120×8×2
		Main	120×8×2

Connection mode of Main Busbar / Branch Busbar

- Main Busbar and Branch Busbar

- | | |
|--|----------------------|
| 1. Main busbar | 5. Branch busbar |
| 2. Wall bushing | 6. Insulation Cover |
| 3. Support pad | 7. Support insulator |
| 4. Main Busbar & Branch Busbar joint insulation boot | 8. Spout |



Connection mode of Main Busbar and Grading ring

In order to better protect the wall bushing, it is necessary to add a grading ring in the wall bushing to balance the voltage between the wall bushing and main busbar. So the grading ring and the main busbar should be connected before doing the routine tests and installation of the Switchgear in the field. As the grading ring is casted into the wall bushing, the wall bushing and the main busbar should be connected by conductor. Here, choose connect the bushing and the main busbar on the outward side of the switchgear for convenience of the connection. (See Figure 6/16)

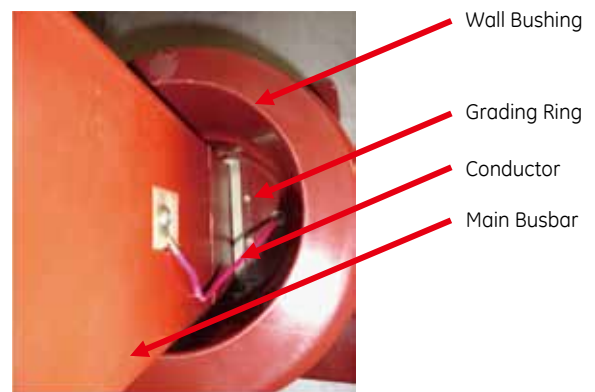


Figure 6/16: Grading Ring and Connecting conductor

Before the connection of grading ring and main busbar, make sure the through threaded hole (M5) on the centerline of main busbar which close the conductor have already tapped according to the length of the conductor. The length between the two hole's center of the conductor is 200mm. The distance between the center of threaded hole and the outer surface of the wall bushing is 150mm (See Figure 6/17).

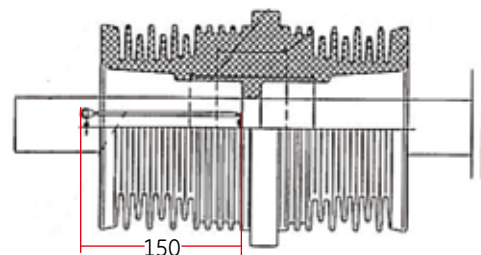


Figure 6/17: Position of the threaded hole

Cut off the heat-shrinkable tube (the surface side which close the conductor) with the area of 30x30mm around the threaded hole (See Figure 6/16).



Figure 6/17

The connection sequence as follows:



Confirm the equipment be powered off and make sure to follow proper safety measures.

- One side of conductor is connected with wall bushing by using one screw(M5X8) and a flat washer, required torque is 5Nm.
- Another side of connecting conductor is connected with main busbar by using another screw(M5X10) and a flat washer, required torque is 5Nm.
- Replacement can be done with the above instructions following the previous instructions in reverse order.

Spare parts

Please refer to recommended spare parts list below. Other spare parts are also available based on customer's requirement.

S/N	Name	Unit	Comments
1	Heater	Piece	
2	Key for door lock	Piece	
3	Earthing switch operating handle	Piece	
4	27KV Service Truck T800	Set	
5	27KV Service Truck T1000	Set	

Appendix A - Onsite service safety instruction

Before operating the equipment, please check and make sure to follow all safety requirement.

If for any reason the work is interrupted, please make sure site safety procedure is followed when restarting the work.

- Before operating, please check site layout, both inside and outside of the electrical operating area, earthing line layout, ON or OFF condition of the control power, state of the temporary power, and if any personnel is present and all safety/emergency exits are clear.
- Ensure if safety procedures on working sheet are well implemented, recheck if the safety procedures comply with requirements, if isolation procedure between live equipment and test equipment is established, and there are clear instructions on the product labels.
- Once equipment is in power off phase, it is strictly forbidden to operate the circuit breaker or switch. Please switch OFF circuit breaker and move VCB to test or withdrawn position. Instrument and power transformer to power of the equipment shall be switched off in order to avoid any unintended charging of the equipment.
- Please confirm the switchgear reference data and series number to avoid working on the wrong equipment.
- All current transformer and voltage transformer secondary winding shall only have one permanent and reliable protective earthing.
- If it is necessary that personnel must service the switchgear, please make sure to contact GE or that site personnel is properly trained and are capable of following proper safety measures.

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